(12) **PATENT**
(19) **AUSTRALIAN PATENT OFFICE**

(11) Application No. **AU 199859441 B2**
(10) Patent No. **734061**

(54) Title
Tapering of sheet material

(51)[6] International Patent Classification(s)
B21D 005/08

(21) Application No: **199859441**

(22) Application Date: **1998.03.23**

(30) Priority Data

(31) Number	(32) Date	(33) Country
PO5881	1997.03.26	AU

(43) Publication Date : **1998.10.01**
(43) Publication Journal Date : **1998.10.01**
(44) Accepted Journal Date : **2001.05.31**

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(56) Related Art
AU 36801/97
AU 40882/96
AU 59702/86

ABSTRACT

A rollforming unit includes a supporting body and a pair of guide roll means mounted in the body for rotation on respective axes. This means includes at least two cooperating pairs of guide rolls for engaging respective ribs of a ribbed formable sheet to guide the sheet through the unit. Rib formation roll means is mounted for rotation in the body and located to ngage a pan of the ribbed formable sheet as it passes through the unit for forming a longitudinally extending rib or ribs in the pan of increasing height, thereby causing the sheet to be tapered. At least some of the guide rolls are slidably mounted on first spindle means and the rib formation roll means includes at least one rib formation roll slidably mounted on second spindle means. The unit further includes means for controllably and progressively relatively moving the slidably mounted rolls along the spindle means to accommodate the tapering of the sheet.

P/00/011
Regulation 3.2

AUSTRALIA

Patents Act 1990

ORIGINAL
COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title: Tapering of sheet material

The following statement is a full description of this invention, including the best method of performing it known to us:

TAPERING OF SHEET MATERIAL

This invention relates to the tapering of rollformed sheet material and has particular though not exclusive application to the formation of tapered forms of the ribbed steel panels commonly used in roofing.

Steel roofing panels are conventionally supplied in a variety of standard lengths, and are provided with longitudinally extending ribs by progressive cold working in a sequence of rollforming stations. Ribbed panels formed in this way may be many metres in length, and typically have rib formations along their side edges which overlap with complementary formations on adjacent panels. There is usually at least one large longitudinally extending intermediate rib and the intervening pans between the major ribs may have shallow ribs for strengthening or decorative purposes.

These conventional forms of ribbed panel are not well suited to roofs of curved configuration, for which panels must be cut to shape and spaces infilled by sheet segments. Stretched membrane configurations have been used for more elaborate roof structures, but ribbed steel panels could often be employed if it were possible to practically and economically produce longitudinally tapered forms of the panels.

Australian patent 576300 describes an apparatus for forming tapered metal sheets employing a sequence of eccentrically mounted forming rolls which act from underneath the sheet to form in each pan a longitudinally extending domed section of increasing height. The lateral drawing of the material of the pan into this domed section causes the side edge ribs to draw closer together, thereby tapering the panel.

The apparatus of patent 576300 requires multiple rollforming stations, and the eccentric mounting of the forming rolls causes additional vibration and noise.

It is an object of the invention to provide one or more novel rollforming arrangements by which tapered panels may be formed from sheet material in a practical and effective manner without incurring the aforementioned disadvantages of the apparatus described in patent 576300.

In the first aspect, the invention provides a rollforming unit, including:

a supporting body;

a pair of guide roll means mounted in said body for rotation on respective axes, which means includes at least two cooperating pairs of guide rolls for engaging respective ribs of a ribbed formable sheet to guide the sheet through the unit;

rib formation roll means mounted for rotation in said body and located to engage a pan of the ribbed formable sheet as it passes through the unit for forming a longitudinally extending rib or ribs in the pan of increasing height, thereby causing the sheet to be tapered;

wherein at least some of the guide rolls are slidably mounted on first spindle means and the rib formation roll means includes at least one rib formation roll slidably mounted on second spindle means;

and wherein the unit further includes means for controllably and progressively relatively moving the slidably mounted rolls along said spindle means to accommodate the tapering of the sheet.

For tapering a sheet having three ribs, two of which may typically be at the side edges of the sheet, there are preferably three guide rolls, the centre one of which is axially fixed with respect to said first spindle means and the other two of which are slidably mounted on the first spindle means.

Preferably, the arrangement of guide rolls provides support for the ribbed sheet at both sides of the or each pan engaged by a rib formation roll. To this end, the guide roll means includes follower guide rolls rotatable on an axis displaced from said first spindle means, which follower guide rolls engage and are mounted to follow the slidably mounted

guide rolls. The sheet is supported between these follower guide rolls and the slidably mounted guide rolls.

Advantageously, the aforementioned axially fixed guide roll has a cooperating guide roll mounted on a bridge extending longitudinally of the unit.

The guide rolls may be integral rolls or formed in plural parts e.g. a pair of discs defining between them a peripheral rib-receiving groove.

Preferably, there are two rib formation rolls for each pan of the sheet, slidably mounted on the second spindle means. Advantageously, there is a further rib formation roll for each pan slidably mounted on the first spindle means and cooperable with the earlier mentioned rib formation rolls in forming two ribs of increasing height in the sheet pan.

Conveniently, the slidable mounting of the slidably mounted rolls is effected by fixing them on respective sleeves, e.g. extending towards one or other end of the associated spindle means. In a case of more than one slidably mounted roll to a given side of the centre point of a spindle means, the sleeve for the innermost roll extends within the sleeve(s) for the more outer roll(s).

Slidable movement of the rolls on the spindle means is preferably effected by respective motor-driven screw actuators. Preferably, each sleeve is carried by a yoke moved by a pair of screw actuators. Preferably, separate motors are provided for the rolls of the respective spindle means, each motor being associated with a single belt drive arranged to provide the different relative speeds of the sleeves.

In a second aspect, the invention provides a roll forming unit, including:

a supporting body;

a pair of guide roll means mounted in said body for rotation on respective axes, which means includes at least two cooperating pairs of guide rolls for

engaging respective ribs of a ribbed formable sheet to guide the sheet through the unit;

rib formation roll means mounted for rotation in said body and located to engage a pan of the ribbed formable sheet as it passes through the unit for forming a longitudinally extending rib or ribs in the pan of increasing height, thereby causing the sheet to be tapered;

wherein said rib formation roll means includes at least one rib formation roll mounted in a sub-body moveably supported on said body;

and wherein means is provided to controllably and progressively move the sub-body so as to correspondingly adjust the position of at least one rib formation roll to effect the longitudinally increasing height of said rib(s) in the pan.

Preferably, the sub-body is moveably supported on the body by being pivotally mounted about an axis which is substantially in the plane of travel of the ribbed sheet through the unit, whereby to minimise longitudinal displacement of the roll tips relative to the sheet with movement of the sub-body.

Preferably, the unit further includes respective sets of feed and exit rolls and an associated motor for rotating these rolls and so moving the ribbed sheet through the unit.

In a preferred embodiment, the invention provides, in the one rollforming unit, the features of both the first and second aspects of the invention.

The invention also provides, in a third aspect, a ribbed metal sheet having a plurality of longitudinally extending pans separated by ribs, wherein each pan includes a pair of longitudinally extending ribs of progressively increasing height, and wherein the sheet is of progressively decreasing width matching the increasing rib height. The ribs of progressively increasing height are preferably substantially V-shaped or triangular in cross section.

The invention will now be further described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic side elevation of a rollforming unit according to an embodiment of both aspects of the invention;

Figure 2 is a vertical cross-section on the line 2-2 on the axes of the respective main roll spindles, with the rolls shown in the pre-taper positions on the right and in their full taper positions on the left;

Figure 3 is a somewhat diagrammatic feed end elevation of the rollforming unit showing only selected components;

Figure 4 is a fragmentary view of one of the four pairs of yokes which carry the slidable rolls;

Figure 5 is a three-dimensional view of a tapered ribbed sheet formed by the unit, together with end elevations and cross-sections where indicated; and

Figure 6 is a diagram showing the control and drive links between the motors and the principal moving components.

The illustrated rollforming unit 10 includes a main body or frame 12 that supports respective sub-bodies comprising an upper sub-frame 14 and a lower sub-frame 15. Sub-frames 14,15 respectively carry an upper roll spindle 16 and lower roll spindle 17. Main frame 10 also mounts driven sets of feed rolls 18 and exit rolls 19, which define a pass plane 20 for a ribbed sheet or panel as it is driven through the unit. The sub-frames 14,15 are between the exit and feed roll sets relative to the direction of sheet travel.

Upper sub-frame 14 is fixed so as to be stationary on main frame 12, whereas lower sub-frame 15 is pivotally mounted at its downstream end on an axis 22, which lies close to and just above plane 20 and extends normal to the direction of sheet travel. At its upstream end, sub-frame 15 sits atop screw jacks 24 (Figure 3), 25 for vertical adjustment of the sub-frame.

As will be discussed in detail, roll spindles 16,17 include various guide and rib formation rolls. Most of these rolls are slidably mounted on the spindles by being attached to sleeves carried by one or other of crossed pairs of yokes 30,31 (Figure 4) at each side of the pass plane. These yokes 30,31 are driven progressively transversely towards or away

from each other by respective pairs of screw actuators 40,41; 42,43 mounted in each sub-frame. Each sub-frame carried a respective motor 46,47 for driving the screw actuators.

The illustrated rollforming unit 10 is configured to taper a particular style of ribbed steel sheet or panel commonly employed in roofing. This panel has three longitudinally extending ribs, one along the centre line and the others at the side edges, joined by a pair of flat pans. It can come in lengths up to 10 metres or more. The unit 10 is designed to form two longitudinally extending ribs in each pan, of progressively increasing height, thereby drawing in material laterally and causing the sheet to be longitudinally tapered. An example of the resultant sheet is illustrated in Figure 5 : the three conventional ribs are indicated at 8, the pans at 9, and the ribs of increasing height at 7. The ribs 7 are substantially V-shaped or triangular in cross-section.

Main frame 12 is a three dimensional rectangular array of heavy duty box-section steel girders. These include a pair of longitudinally extending upper beams 50,51 atop three spaced legs 52, having base pads 53 and joined by lower longitudinal beams 54. Upper beams 50,51 and legs 52 are in turn linked by a number of cross beams 56 indicated by broken line outlines in Figure 1. Beams 50,51 overhang the legs 52 at the feed end to support feed roll set 18, while exit roll set 19 is carried by upper beams 50,51 just upstream of the middle leg. The rolls of sets 18,19 are not depicted in detail, but comprise any suitable arrangement to drive and guide ribbed panels along pass plane 20. The rolls of feed roll set 18 and exit roll set 19 are driven from a motor 45 via a longitudinally extending drive shaft 58, respective gear boxes 59a,59b, and drive belts 55.

The configuration of guide rolls and rib formation rolls is best seen in the cross sectional view of Figure 2. Each of the spindles 16,17 is of solid steel, turned to provide the profiles illustrated in the drawings. Each is rotationally supported by roller bearings 70a,70b in end block assemblies 72a,72b by which they are detachably mounted in cut-outs 73 of side plates 74,75; 84,85 of the respective sub-frames 14,15.

Upper roll spindle 16, which does not move vertically, has three guide rolls 101,102,103, each of double disc construction, and a pair of rib formation rolls 111,112

between the guide rolls. The two disc components of centre guide roll 102, i.e. discs 102a,102b, define between them a peripheral groove 121 to receive and guide the centre rib of the metal panel, and are mounted irrotationally on a raised centre land 122 of spindle 16. The roll discs are retained against an integral flange 123 of the spindle by a thrust ring 124. Roll 102 thereby rotates with the spindle.

Rib formation rolls 111,112 are slidably mounted on spindle 16 by being attached as shown to respective sleeves 125a,125b. Sleeves 125a,125b are slidably supported on the spindle and extend towards the respective ends of the spindle. Outer drive rolls 101,103, which are arranged to engage and guide the side ribs of the metal panel, are of similar dual disc construction to roll 102 and are slidably and rotatably mounted on the spindle by being fixed to respective shorter sleeves 128a,128b. These latter sleeves are slidably and rotatably supported on sleeves 125a,125b. Sleeves 125a,125b;128a,128b are keyed to spindle 16 so as to rotate in unison with the spindle. Lubricant is delivered to the respective journal bearings defined by the sleeves via axial bores 129a in the spindle, and transverse pin holes 129b,129c in the spindle and in the inner sleeves 125a,125b.

Lower roll spindle 17, which is vertically moveable by being retained in pivotally mounted sub-frame 15, carries four rib formation rolls 113,114,115,116. These rolls are disposed, when viewed in the common axial cross section of Figure 2, alternatively between the five rolls on the upper spindle. They are slidably mounted on spindle 17 by being fixed to respective sleeves 135a,135b;138a,138b, former within the latter, in a manner similar to the arrangement of the sleeves of the upper spindle. Again, the sleeves are keyed to the spindle so as to rotate in unison with the spindle.

The outer ends of the various sleeves are rotationally carried by centre bosses of respective yokes 30,31, already adverted to. Towards each end of each spindle, there is a pair of these yokes : an inner yoke 30 carrying the outer sleeve (128a,128b,138a or 138b) and an outer yoke 31 attached to the longer and inner sleeves (125a,125b,135a or 135b) respectively. Within each sub-frame, these pairs of yokes 30,31 are crossed at an angle of about 25° or so and adjacent their outer ends carry internally threaded sleeves or ferrules by which they receive threaded rods 140 of screw actuators 40-43. Rods 140 extend

transversely of the unit and engage a yoke at each side : opposite movement of the yokes is achieved by opposite hand threads.

Rotation of the rods draws the sleeves or ferrules of the yokes along the rods. As will be better understood shortly, when the roll forming unit is in operation, the rolls carried by the inner and longer sleeves need to travel faster along the spindles than the rolls carried by the outer and shorter sleeves. Thus, the outer yokes 31 must be driven by their actuators at a higher speed than the inner yokes 30. This is achieved by means of primary drive belt 150 at one side of each sub-frame that links motor 46 or 47 to sprockets on lower rods 140 in the appropriate speed ratio (discussed further below). Motors 46,47 are mounted to one of the side plates (74), while adjacent the other side plates (75) are crossed belts (not shown) that link the lower screw rods to the opposite upper screw rod of the same yoke in a 1:1 ratio.

The ribbed metal sheet is supported and guided between the guide rolls 101,102,103 and respective underlying follower rolls 104,105,106. The central follower roll 105 is a pair of roller bearings carried on a hub 162 centrally of a longitudinally extending bridge 160 forming part of the upper sub-frame 14. The outer follower rolls 104,106 are rotatably supported on respective secondary spindles 162a,162b. These spindles can freely move transversely of the direction of travel and are slidably supported to this end in longitudinally extending side bridges 164a,164b. Rolls 104,106 track transversely with rolls 101,103 by virtue of a respective peripheral lip 166 on rolls 104,106 which engages rib guiding groove 121a of the overlying roll 101,103. The dimensions are such that both the lip 166 and the rib of the metal sheet can engage groove 121a side-by-side without risk of seizure.

The facility to progressively raise sub-frame 15 towards sub-frame 14 has already been noted. The pivotal mounting of the lower sub-frame on axis 22 in the pass plane 20 is achieved by suspending end portions 85a of side plates 84,85, on stub axles 182,183 of respective support units 180,181 mounted atop main frame beams 50,51. The vertical adjustment of the lower sub-frame is achieved by a pair of screw jacks 24,25 affixed on a cross beam 56a and driven by screw jack motor 48.

The operation of the unit to form tapered ribbed steel sheet will now be described. A three ribbed panel or sheet of the form earlier described is introduced to the feed rollers and driven along the pass plane 20. The sheet may typically be surface treated, eg. a galvanised, zincalume coated, colorbond or painted steel sheet. The ribs 8 (Figure 5) of the panel engage and rotate the guide rolls 101-106. The panel moves through the unit as sub-frame 15 is controllably and progressively raised by the action of motor 48 on screw jacks 24,25. Lower rib formation rolls 113-116 are thereby steadily uplifted and cooperate with the upper rib formation rolls 111,112 to engage and deform the pans of the sheet to form longitudinally extending ribs 7 (Figure 5), two in each pan, of progressively increasing height. The resultant lateral drawing of material in turn causes a narrowing, i.e. tapering, of the panel. The narrowing of the sheet is accommodated by the action of motors 46,47, which, through screw actuators 40-43, progressively and controllably drive the various slidably mounted rolls inwardly towards each other. It is thought that this action should be a driven and positive action rather than simply a follower action as the sheet narrows, in order to ensure maximum control of the process. For similar reasons, it is thought desirable to properly support the sheet to each side of the rib formation regions by the lower guide rolls 104,105,106 as well as main upper guide rolls 101,102,103.

There will of course be a limitation on the amount of taper which can be formed in a single pass of unit 10 without incurring undesirable damage in the metal sheet, e.g. fracturing or unacceptable deformation. Multiple passes will usually be required to achieve high angle tapers, with each successive pass further increasing the maximum height of the formed ribs 7 and further reducing the width of the sheet at the narrow end.

It will be appreciated that the motors 45-48 will typically be controlled by associated programmable logic control equipment under software control. Such equipment will include a keyboard and monitor by which appropriate parameters can be entered for each sheet (e.g. the desired taper per unit length and sheet travel speed) to determine the speed of motor 46, which in turn is linked to the other components according to the control and drive links, and ratios, depicted in Figure 6. The mentioned electronic cam is based on

a table derived from forming geometry. Such control technology is generally well known in the rollforming art.

The innermost position of the slidable rolls is shown at the left in Figure 2. This of course determines the minimum width of the tapered panel at its narrower end. It will be seen that the capacity to crowd the rolls to optimise the extent of tapering achievable is facilitated by careful design of the rolls. The inner faces of lower rib formation rolls 114,115 each have a shallow annular groove 130 to accommodate the hub 162 supporting the roller bearings forming centre follower roll 105. The peripheral tips of all of the rib formation rolls are tapered radially and rounded for optimum forming characteristics, and also so as to physically interleave to allow minimisation of the pan width at maximum taper. To further reduce the risk of cracking, the rib formation rolls are of so-called soft rollforming material and have small radius tips. The outside lower rib formation rolls 113,116 have integral mounting bosses formed on their axially outside faces to allow these rolls to locate closely to rolls 114,115. The dual disc guide rolls 101,102,103 are all of reduced axial length about the spindle 16.

A useful maintenance feature of rollforming unit 10 is the ability to lift out each of the spindle/roll assemblies from their respective sub-frames. This is possible because of the use of separate end block assemblies 72a,72b by which the spindles are supported in the side plates of the sub-frames, and by the divisible construction of yokes 30,31. As best seen in Figure 4, each yoke comprises a centre segment 170 including a boss 172 by which the yoke is mounted to its respective roll-carrying sleeve, and a pair of end segments 174,175 secured to the respective threaded sleeves or ferrules. As best seen in Figure 2, boss 172 is retained on a roller bearing 173 retained on the sleeve by a screw-fastened ring 177. Centre segments 170 and end segments 174,175 are assembled together by securing together superposed tab portions with fasteners 178.

It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or drawings. All of these different combinations constitute various alternative aspects of the invention.

It will also be understood that the term "comprises" or its grammatical variants as used herein is equivalent to the term "includes" and is not to be taken as excluding the presence of other elements or features.

CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A rollforming unit, including:

a supporting body;

a pair of guide roll means mounted in said body for rotation on respective axes, which means includes at least two cooperating pairs of guide rolls for engaging respective ribs of a ribbed formable sheet to guide the sheet through the unit;

rib formation roll means mounted for rotation in said body and located to engage a pan of the ribbed formable sheet as it passes through the unit for forming a longitudinally extending rib or ribs in the pan of increasing height, thereby causing the sheet to be tapered;

wherein at least some of the guide rolls are slidably mounted on first spindle means and the rib formation roll means includes at least one rib formation roll slidably mounted on second spindle means;

and wherein the unit further includes means for controllably and progressively relatively moving the slidably mounted rolls along said spindle means to accommodate the tapering of the sheet.

2. A rollforming unit according to claim 1 wherein the arrangement of said guide roll means provides support for the ribbed sheet at both sides of the or each pan engaged by said rib formation roll means.

3. A rollforming unit according to claim 2 wherein said guide roll means includes follower guide rolls rotatable on an axis displaced from said first spindle means, which follower guide rolls engage and are mounted to follow the slidably mounted guide rolls.

4. A rollforming unit according to claim 1 wherein, for tapering a sheet having three ribs, there are three guide rolls, the centre one of which is axially fixed with respect to said first spindle means and the other two of which are slidably mounted on the first spindle means.

5. A rollforming unit according to claim 4, wherein said axially fixed guide roll has a cooperating guide roll mounted on a bridge extending longitudinally of the unit.

6. A rollforming unit to any preceding claim wherein said guide rolls are integral rolls.

7. A rollforming unit according to any one of claims 1 to 5 wherein and guide rolls are formed in plural parts e.g. a pair of discs defining between them a peripheral rib-receiving groove.

8. A rollforming unit according to any preceding claim wherein there are two of said rib formation rolls for each pan of the sheet, slidably mounted on the second spindle means.

9. A rollforming unit according to claim 8 wherein there is a further said rib formation rolls for each pan slidably mounted on the first spindle means and cooperable with said two rib formation rolls in forming two ribs of increasing height in the sheet pan.

10. A rollforming unit according to any preceding claim wherein said slidably mounted rolls are slidably mounted by fixing them on respective sleeves.

11. A rollforming unit according to claim 10 wherein said sleaves extend towards one or other end of the associated spindle means.

12. A rollforming unit according to claim 10 and 11 wherein there is more than one slidably mounted roll to a given side of the centre point of a spindle means, and the sleeve for the innermost roll extends within the sleeve(s) for the more outer roll(s).

13. A rollforming unit according to any preceding claim further including respective motor-driven screw actuators for effecting sliding movement of said rolls on the spindle means.

14. A rollforming unit according to claim 13 wherein each sleeve is carried by a yoke moved in operation by a pair of said screw actuators.

15. A rollforming unit according to claim 14 wherein separate said motors are provided for the rolls of the respective spindle means, each motor being associated with a single belt drive arranged to provide the different relative speeds of the sleeves.

16. A rollforming unit according to any preceding claim wherein said rib formation roll means includes at least one rib formation roll mounted in a sub-body moveably supported on said body, and wherein means is provided to controllably and progressively move the sub-body so as to correspondingly adjust the position of at least one rib formation roll to effect the longitudinally increasing height of said rib(s) in the pan.

17. A rollforming unit according to claim 16 wherein said the sub-body is moveably supported on the body by being pivotally mounted about an axis which is substantially in the plane of travel of the ribbed sheet through the unit, whereby to minimise longitudinal displacement of the roll tips relative to the sheet with movement of the sub-body.

18. A rollforming unit, including:

a supporting body;

a pair of guide roll means mounted in said body for rotation on respective axes, which means includes at least two cooperating pairs of guide rolls for engaging respective ribs of a ribbed formable sheet to guide the sheet through the unit;

rib formation roll means mounted for rotation in said body and located to engage a pan of the ribbed formable sheet as it passes through the unit for forming a longitudinally extending rib or ribs in the pan of increasing height, thereby causing the sheet to be tapered;

wherein said rib formation roll means includes at least one rib formation roll mounted in a sub-body moveably supported on said body;

and wherein means is provided to controllably and progressively move the sub-body so as to correspondingly adjust the position of at least one rib formation roll to effect the longitudinally increasing height of said rib(s) in the pan.

19. A rollforming unit according to claim 18 wherein said sub-body is moveably supported on the body by being pivotally mounted about an axis which is substantially in the plane of travel of the ribbed sheet through the unit, whereby to minimise longitudinal displacement of the roll tips relative to the sheet with movement of the sub-body.

20. A rollforming unit to any preceding claim further including respective sets of feed and exit rolls and an associated motor for rotating these rolls and so moving the ribbed sheet through the unit.

21. A ribbed metal sheet having a plurality of longitudinally extending pans separated by ribs, wherein each pan includes a pair of longitudinally extending ribs of progressively increasing height, and wherein the sheet is of progressively decreasing width matching the increasing rib height.

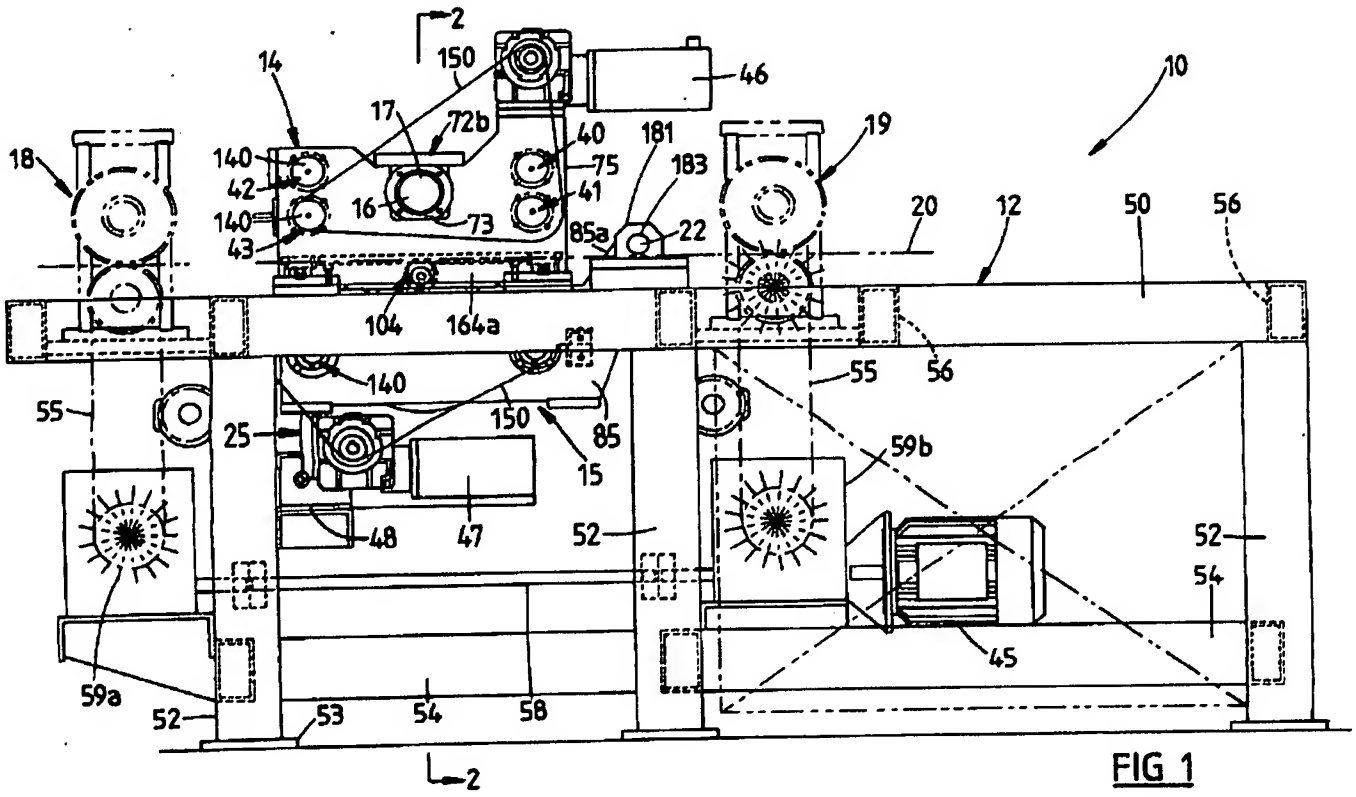
22. A ribbed metal sheet according to claim 21 wherein said ribs of progressively increasing height are substantially V-shaped or triangular in cross section.

23. A ribbed metal sheet substantially as herebefore described with reference to Figure 5 of the accompanying drawings .

24. A rollforming unit substantially as herebefore described with reference to Figures 1 to 4 and 6 of the accompanying drawings.

BHP Steel (JLA) Pty Ltd
by Freehills Patent Attorneys
Patent Attorneys for the Applicant

20 March 1998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46
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164a
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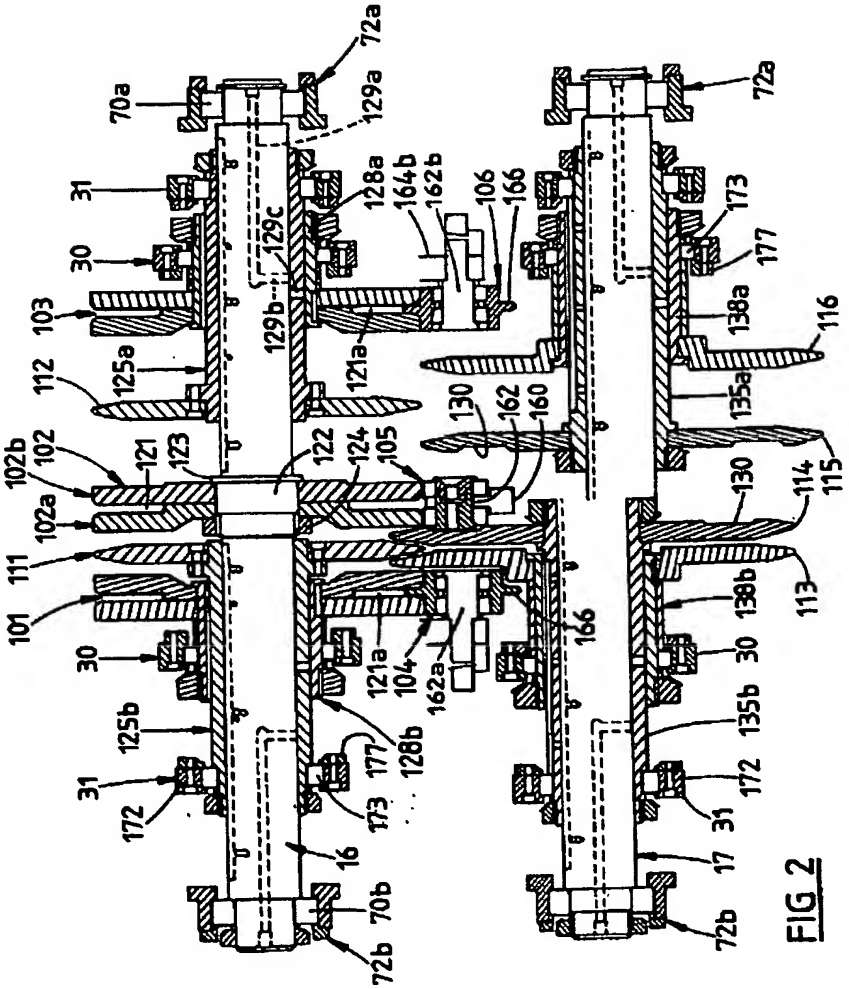
2

FIG 1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129b
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112
125a
121a
135a
130
162
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102b
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121
123
122
124
105
114
115
102a
111
101
138b
113
30
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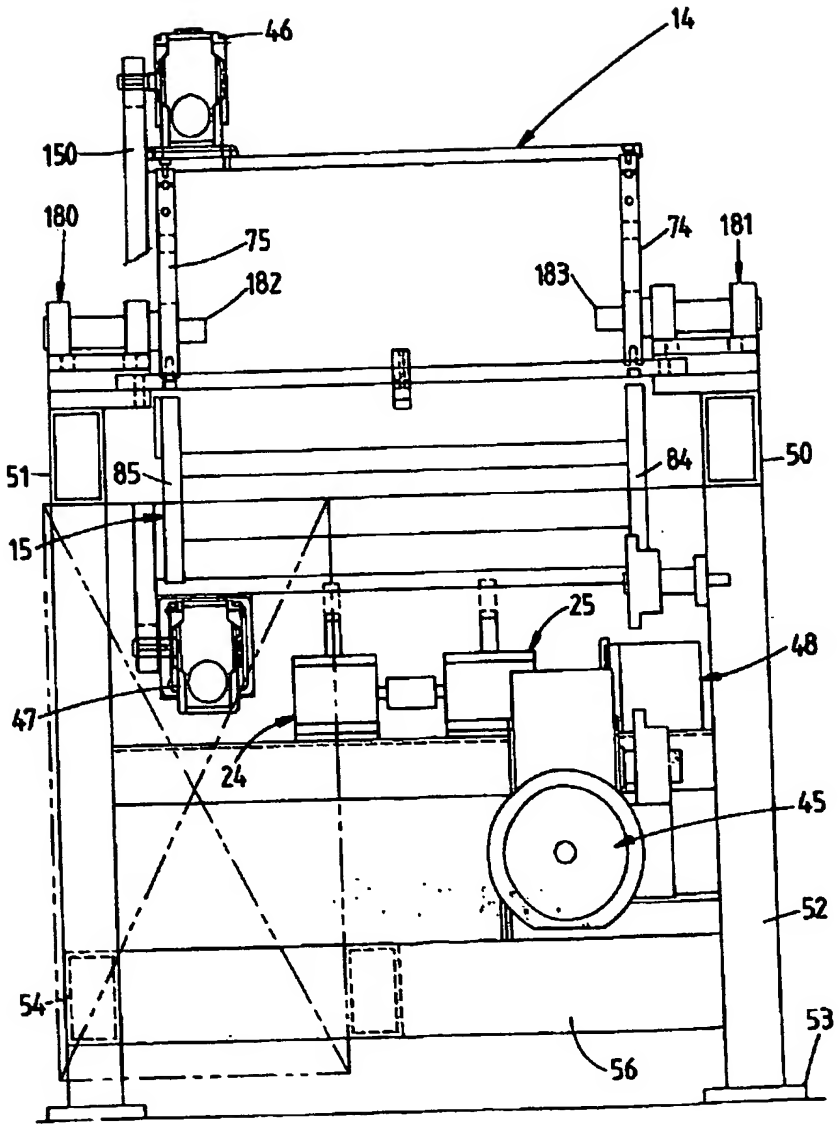
172
173
16
17
70b
72b
FIG 2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14
150
180
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53
56

FIG 3

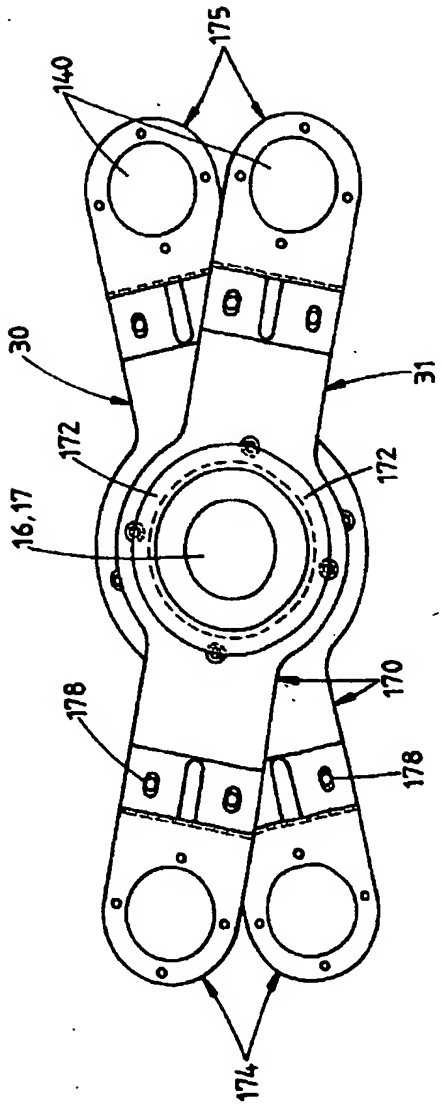

FIG 4

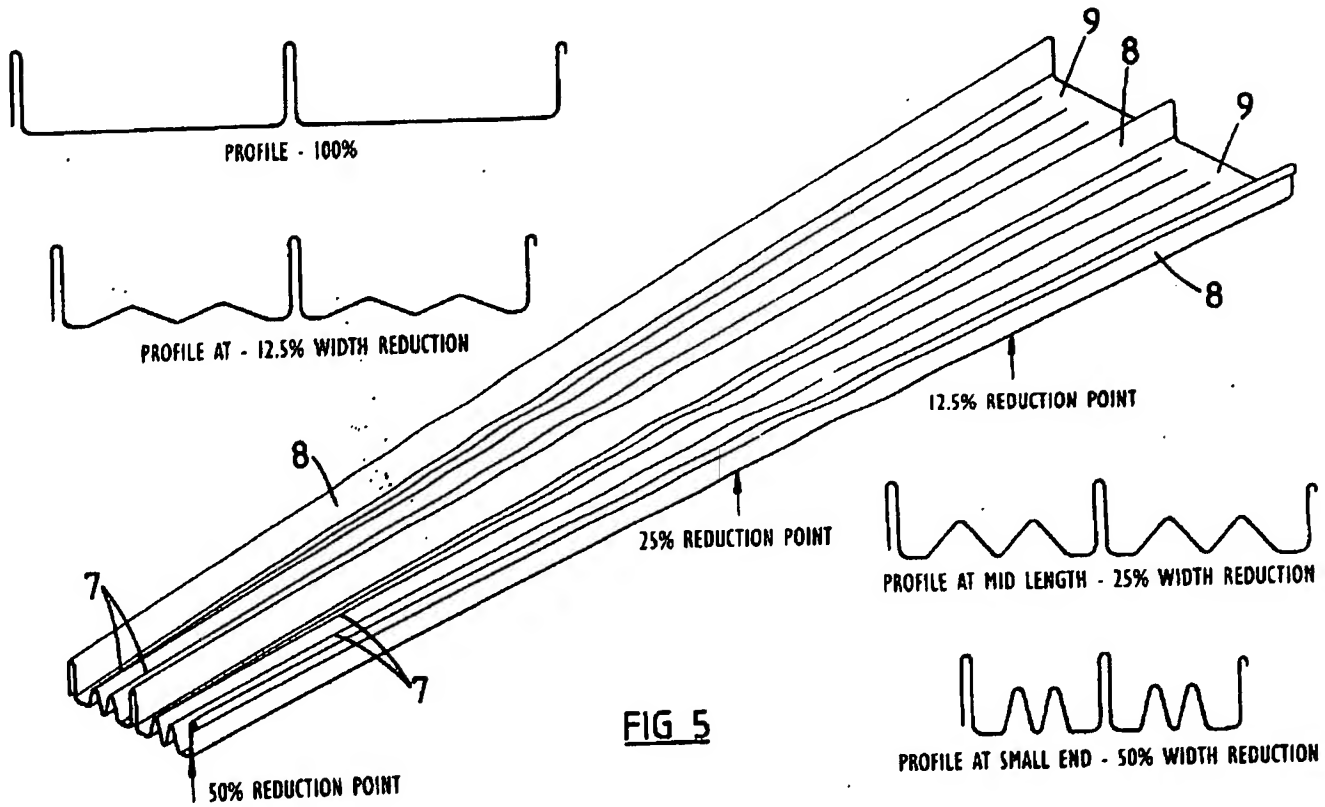
PROFILE - 100%
PROFILE AT - 12.5% WIDTH REDUCTION
9
8
9
8
12.5% REDUCTION POINT
8
25% REDUCTION POINT
7
7
50% REDUCTION POINT
PROFILE AT MID LENGTH - 25% WIDTH REDUCTION
PROFILE AT SMALL END - 50% WIDTH REDUCTION

FIG 5

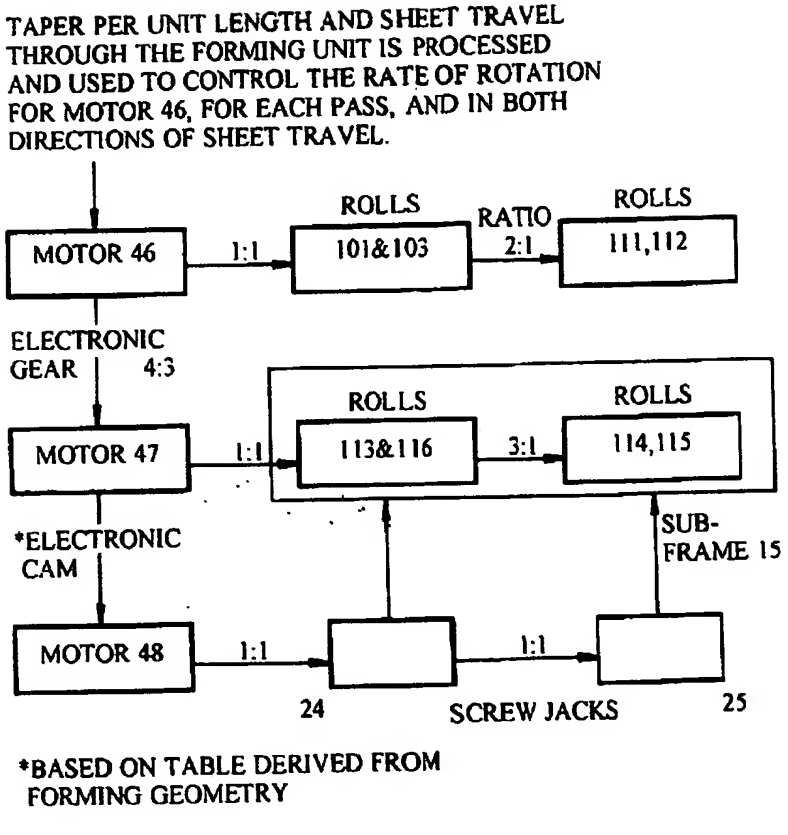
TAPER PER UNIT LENGTH AND SHEET TRAVEL THROUGH THE FORMING UNIT IS PROCESSED AND USED TO CONTROL THE RATE OF ROTATION FOR MOTOR 46, FOR EACH PASS, AND IN BOTH DIRECTIONS OF SHEET TRAVEL.
MOTOR 46
1:1
ROLLS
101&103
RATIO
2:1
ROLLS
111,112
ELECTRONIC GEAR
4:3
MOTOR 47
1:1
ROLLS
113&116
3:1
ROLLS
114,115
*ELECTRONIC CAM
SUB-FRAME 15
MOTOR 48
1:1
1:1
24
SCREW JACKS
25
*BASED ON TABLE DERIVED FROM FORMING GEOMETRY

FIG 6